



U.S. Department
of Transportation

**Research and
Special Programs
Administration**

JAN 10 2000

400 Seventh Street, S.W.
Washington, D.C. 20590

DOT-E 10603
(THIRD REVISION)

EXPIRATION DATE: December 31, 2001

(FOR RENEWAL, SEE 49 CFR § 107.109)

1. GRANTEE: UEF Chesterfield Cylinders, Derbyshire, England
(Formerly: Chesterfield Cylinders)
(U.S. Agent: BIE International Inc., Houston,
TX)
2. PURPOSE AND LIMITATIONS:

This exemption authorizes the manufacture, mark, sale and use of a non-DOT specification cylinder conforming with all regulations applicable to a DOT 3AA specification cylinder, except as specified herein, for the transportation in commerce of the materials authorized by this exemption. This exemption provides no relief from any Hazardous Materials Regulation (HMR) other than as specifically stated herein.
3. REGULATORY SYSTEM AFFECTED: 49 CFR Parts 106, 107 and 171- 180.
4. REGULATIONS FROM WHICH EXEMPTED: 49 CFR §§ 173.301, 173.302, 173.304, 175.3, 178.45 in that non-DOT specification cylinders are not authorized.
5. BASIS: This exemption is based on the application of UEF Chesterfield Cylinders dated October 11, 1999, submitted in accordance with § 107.109.

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6. HAZARDOUS MATERIALS (49 CFR § 172.101):

Proper Shipping Name/ Hazardous Material Description	Hazard Class/ Division	Identi- fication Number	Packing Group
Nonliquefied compressed gases, or mixtures of such compressed gases, classed as Division 2.1, (flammable gas) Division 2.2, (nonflammable gas) or Division 2.3, (gases which are Poisonous by Inhalation (PIH)) which are authorized in the Hazardous Materials Regulations to be transported in DOT 3AA specification cylinders, except that the following are not authorized: (a) Hydrogen, compressed natural gas, hydrogen sulphide, or carbon monoxide;	Specific Hazard Class and Division applicable and as appropriate to the compressed gas or gas mixture to be shipped.	As appropriate	N/A
(b) Any gas mixture containing free sulphides, or hydrogen, or compressed natural gas; (c) Any gas mixture containing more than 10% carbon monoxide; (d) Any gas mixture containing carbon monoxide and having a dew point higher than minus 52°F at one atmosphere; (e) Any gas or mixture of gases which does not remain in gaseous state when contained in the cylinder at 70°F and rated filling pressure; and (f) Any mixture of gases, the quantity of one or more of which is capable of combining chemically with other gases in such a mixture; or can cause cylinder material degradation by corrosion, stress corrosion, embrittlement, or enhanced fatigue crack growth.	Specific Hazard Class and Division applicable and as appropriate to the compressed gas or gas mixture to be shipped.	As appropriate	N/A

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7. SAFETY CONTROL MEASURES:

a. PACKAGING - Packaging prescribed is a non-DOT specification steel cylinder made in accordance with Chesterfield Cylinders Ltd.'s drawing number 48613P Rev. 1 or 49362P, and information as to material selection, design, and performance described in the application and supplemental information thereto, dated 12 July 1993, on file with the Office of Hazardous Materials Exemption and Approvals (OHMEA). The cylinders authorized under this exemption must be in conformance with DOT-3AA specification (§§ 178.35 and 178.37), except as follows:

§ 178.35(c) *Duties of inspector*

(1) and (2) * * *

(3) * * *

(i) through (iv) * * *

(v) Witness all tests except the fracture toughness test described in paragraph 8(a) of this exemption provided the fracture toughness test is performed by a facility acceptable to the Inspector and a certified report of the test results is furnished to the Inspector by the test facility;

(vi) through (viii) * * *

(ix) Verify that material and design qualification tests prescribed in § 178.37-8(e) of this exemption have been performed with satisfactory results.

§ 178.35(e) *Pressure relief devices and protection for valves and pressure relief devices.*

(Add)

Pressure relief devices must be in compliance with § 173.302(c)(1), except as follow:

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(1) Cylinders charged with gas mixtures containing any gas classed as Division 2.3 Hazard Zone A must not be equipped with any pressure relief device.

(2) Cylinders charged with gas mixtures that do not contain a hazardous material classed as Division 2.3, must be equipped with a combination rupture disk and fusible plug pressure relief device in compliance with CGA Pamphlet S-1.1.

§ 178.37(a) *Type, size and service pressure*

(1) Seamless, 120 pounds maximum water capacity, 0.250 inch minimum wall thickness and a service pressure not to exceed 5000 psig.

(2) Not applicable.

§ 178.37(b) *Authorized steel.*

The provisions remain the same except the steel analysis must conform to the following:

ANALYSIS TOLERANCES

<u>Element</u> (percent)	<u>Ladle analysis</u>	<u>Check Analysis</u>	
		<u>Under</u>	<u>Over</u>
Carbon	.32/.36	0.01	0.02
Manganese	.60/.90	0.03	0.03
Phosphorus	.010 Max.	-	0.01
Sulfur	.005 Max.	-	0.00
Silicon	.15/.35	0.02	0.02
Chromium	.80/1.10	0.03	0.03
Molybdenum	.43/.50	0.03	0.03
Aluminum	.01/.05	0.00	0.00

Note: Steel shall be aluminum killed and made by a fine grain deoxidation practice.

§ 178.37(d) *Manufacture*

Add the following:

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(1) Metal removal for any purpose other than removal of isolated defects and threading must be done prior to hydrostatic test. The thickness of the treated areas must be measured and may not be less than the minimum prescribed thickness.

(2) Each cylinder must be of seamless construction manufactured by the backward extrusion method with integrally formed heads and bottoms. Closure of the cylinder to form the neck must be by hot spinning.

(3) The thickness at the bottom of cylinder may not be less than two times the minimum wall thickness of the cylindrical shell; such bottom thickness to be measured within an area bounded by a line representing the points of contact between the cylinder and floor when the cylinder is in a vertical position.

(4) The shape and thickness of the cylinder bottom and sidewall adjacent to the bottom must be such that failure during the cyclic pressure test occurs in the sidewall of the cylinder.

(5) Each design authorized herein must be qualified for production by subjecting at least three prototype samples to pressure cycling tests and burst test as follows:

(i) Cycle test: The cycle test must be performed on completed cylinders after hydrostatic test by subjecting the cylinder to successive hydrostatic pressurization from a lower cyclic pressure to an upper cyclic pressure at a rate not to exceed 10 cycles per minute. Adequate recording instrumentation shall be provided if equipment is to be left unattended for any period of time. The lower cyclic pressure may not exceed 10 percent of the upper cyclic pressure. The upper cyclic pressure must be at least equal to the minimum prescribed test pressure.

(ii) Burst pressure test: The burst pressure test must be performed on the completed cylinder by hydrostatically pressurizing the cylinder to

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destruction. Rate of pressurization may not exceed 200 psi per second.

(6) Ultrasonic Examination:

Each cylinder produced under the terms of this exemption shall be examined after heat treatment by shear wave ultrasonic equipment which has been calibrated to give an indication equivalent of a 5% of wall thickness by 1" long notch. Procedures must be in accordance with ASTM E213-86 (re-approved in 1990) including supplementary requirements. When immersion method is used, the method must conform to the ASTM Standard E-214-68 (reapproved in 1991). Ultrasonic test results must be recorded by individual cylinder serial number and maintained as long as the cylinder is in service.

(7) Lot definition.

In this exemption, a "lot" means a group of cylinders successively produced and having the same:

- (i) Size and configuration;
- (ii) Specified material of construction;
- (iii) Process of manufacture and heat treatment;
- (iv) Equipment of manufacture and heat treatment;
- (v) Conditions of time, temperature and atmosphere during heat treatment.

The lot size may not exceed 200 cylinders, but any cylinder processed for use in the required destructive testing need not be counted as being one of the 200.

§ 178.37(e) *Welding or brazing*

Welding or brazing is prohibited.

§ 178.37(f) *Wall thickness*

(1) The minimum wall thickness must be such that the wall stress at the minimum prescribed test pressure does not exceed 67 percent of the minimum tensile strength of the steel as determined by the mechanical tests required in Sections 178.37(j) and 178.37(k). A wall stress of more than 104,000 psi is not permitted.

(2) Calculation must be based on the specified minimum wall thickness and made by the formula:

$$S = P(1.3D^2 + 0.4d^2)/(D^2 - d^2)$$

where:

S = wall stress in pounds per square inch;
P = minimum test pressure, at least 3/2 times the service pressure;
D = outside diameter in inches;
d = inside diameter

§ 178.37(g) *Heat treatment*

Each cylinder must be uniformly and properly heat treated prior to tests. Heat treatment of cylinders shall be as follows:

(1) The furnace must be equipped with instrumentation capable of continuously recording pyrometric controls determining cylinder temperature within + or - 18°F, in both the austenitizing and tempering sections at the beginning and end of each soak zone. The furnace shall have fault controls providing uniform temperature in each control zone and proper function of the feed mechanism.

(2) Each cylinder shall be maintained at the austenitizing temperature for a time period not less than one hour per inch of maximum measure wall thickness, followed by immediate quenching in mineral oil or other suitable medium having a cooling rate not exceeding 80 percent that of water. Cylinder wall temperature before the start of quenching shall be at least 1610°F but not exceeding 1650°F.

(3) After quenching, each cylinder must be immediately reheated to a tempering temperature below the transformation range but not less than 1060°F, and must be held at this temperature for at least one hour per inch of thickness based on the maximum thickness of the cylinder. Each cylinder must then be air cooled.

(4) Following the heat treatment to confirm that the required tensile strength is achieved a hardness test shall be carried out on each cylinder in accordance with requirements in § 178.37(j)(3) of this exemption.

§ 178.37(h) *Openings.*

(1) Openings are permitted in the cylinder head only.

(2) All openings must be threaded. Threads must be in compliance with the following:

(i) Each thread must be clean cut, even, without checks, and to gauge.

(ii) Taper threads, when used, must be in compliance with one of the following.

(a) American Standard Pipe Thread (NPT) type must be in compliance with the requirements of Federal Standard H-28 (1978), Section 7.

(b) National Gas Taper Thread (NGT) type must be in compliance with the requirements of Federal Standard H-28 (1978), Sections 7 and 9.

(c) Other taper threads conforming with other standards may be used provided the length is not less than that specified for NPT threads.

(iii) Straight threads when used must be in compliance with one of the following:

(a) National Gas Straight Thread (NGS) type must be in compliance with the requirements

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of Federal Standard H-28 (1978), Sections 7 and 9.

(b) Unified Thread (UN) type must be in compliance with the requirements of Federal Standard H-28 (1978), Section 2.

(c) Controlled Radius Root Thread (UNJ) type must be in compliance with the requirements of Federal Standard H-28 (1978), Section 4.

(d) Other straight threads in compliance with other recognized standards may be used provided that the requirements of paragraph (iv) below are met.

(iv) All straight threads must have at least 6 engaged threads, a leak tight fit, and a factor of safety in shear of at least 10 at the test pressure of the cylinder. Shear stress must be calculated by using the appropriate thread shear area in accordance with Federal Standard H-28 (1978), Appendix A5, Section 3.

§ 178.37(i) *Hydrostatic test.*

(1) Applies except that only the water jacket method is authorized.

(2) * * *

(3) * * *

(4) Each cylinder must be tested to at least 3/2 times service pressure.

(5) A rejection elastic expansion (REE) limit must be developed as specified in CGA pamphlet C-5. If the elastic expansion of any cylinder at test pressure exceeds the limit so developed, that cylinder must be rejected.

§ 178.37(j) *Flattening and ductility tests.*

(1) Flattening test: Between knife edges, wedge shaped, 60 degree angle, rounded to 1/2 inch radius; test 1 cylinder taken at random out of each lot of

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200 or less cylinders. Longitudinal axis of the cylinder must be at approximately a 90-degree angle to knife edges.

(2) Impact tests:

(i) Three Charpy impact specimens must be prepared from one cylinder taken from each lot after heat treatment, and tested at minus 60°F (minus 50°C) or colder. When the cylinders in a lot are made from different heats of steel, the test cylinder from one of the heats in that lot may represent all the heats, provided all other heats in that lot were previously qualified. New impact tests are required for each 200 cylinders consecutively produced from any one heat.

(ii) Each impact specimen must be Charpy V-notch type of size 10mm X 4mm or 10mm X 5mm taken in accordance with ASTM Standard A370-92.

(iii) Each specimen must be taken from the sidewall of the cylinder. The longitudinal axis of the specimen must be at 90 degrees to the longitudinal axis of the cylinder.

(3) Hardness measurement: A hardness measurement must be performed on the cylindrical section of each cylinder after heat treatment in accordance with ASTM Standard A-370. At a minimum, one reading must be taken in the cylindrical region and one reading at about 6 inches from the bottom of the cylinders. The results must be recorded.

(4) Flawed cylinder pressure test:

(i) One cylinder must be selected from each heat of steel and subjected to a preflawed cylinder burst test. A sharp part through longitudinal flaw must be introduced into the test cylinder by a means that will not affect the metallurgical properties of the cylinder. The flaw must be machined with a standard Charpy V-notch cutter, and at least 2.2 inches long and have a depth that will cause the cylinder to fail when pressurized to not less than 100 percent and not more than 125 percent of the

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stress at the marked service pressure. The cylinder must be hydrostatically pressurized to failure at a rate not in excess of 200 psi per second.

(ii) For each cylinder tested as above, an evaluation of relative toughness, the ratio of the hoop stress at the time leak started to the hoop stress at failure under fully plastic condition for each cylinder tested must be performed, using Chesterfield's procedure on file with OHMEA.

§ 178.37(1) *Acceptable results of tests and inspections.*

(1) Physical Test:

(i) Tensile strength at least 155,000 psi and not more than 175,000 psi.

(ii) Elongation at least 16 percent for gauge length 2 inches with width not over 1-1/2 inches.

(2) Flattening test: Flattening required without cracking to 8 times wall thickness. Maximum degree of flattening attained without cracking must be entered on the inspector's report.

(3) Impact test: The Charpy V-notch impact properties for the three impact specimens which must be tested at minus 60°F (minus 50°C) or colder may not be less than the values shown below:

<u>Size</u> <u>(mm)</u>	<u>Avg. value for</u> <u>acceptance 3</u> <u>specimens</u>	<u>Min.value</u> <u>1 specimen only</u> <u>of the three</u>
10 x 5 or 10 x 4	18 ft. lbs	13 ft. lbs

(4) Hardness measurement: The tensile strength equivalent of the hardness number obtained may not be more than Rc 40 (Brinell 371). When the result of a hardness test exceeds the maximum permitted, two or more hardness measurements may be made; however, the hardness number obtained in any retest may not exceed the maximum permitted.

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(5) Flawed cylinder pressure test: The failure must be by leakage without crack extension, or by plastic fracture with visible evidence of bulging. The relative toughness shall not be less than 0.75.

(6) Ultrasonic examination: Any cylinder having a discontinuity greater than the equivalent of 5 percent of wall thickness by 1 inch long notch must be rejected. Any cylinder with rejectable ID indication shall be scrapped and destroyed.

(7) Cycle test: Cylinders subjected to design qualification cycle tests prescribed in Section 178.37(d)(5) in this exemption must withstand at least 10,000 cyclic pressurization without distortion or failure. At least one cylinder must be cycled using water as the pressurizing medium.

(8) Burst tests: Cylinders subjected to design qualification tests must withstand a pressure of at least 2.25 times the service pressure without failure. Failure must initiate in the sidewall in a longitudinal direction, and the cylinder must remain in one piece.

§ 178.37(m) *Leakage test.*

Not Applicable

§ 178.37(n) *Rejected cylinders.*

If any lot in an already accepted heat fails any of the qualification tests as prescribed in Sections 178.37(d), 178.37(i), and 178.37(j) of this exemption, that lot may be subjected to one repeated heat treatment. Any lot subjected to second heat treatment is considered as equivalent to a new heat and therefore must pass all prescribed tests. Acceptable results are prescribed in Section 178.37(l) of this exemption. If any lot subjected to a second heat treatment fails any of the prescribed mechanical tests, the cylinders from that lot may not be used under the terms of this exemption.

(1) Lot requalification:

(i) The second heat treatment procedure shall be in accordance with that prescribed in Section 178.37(g) of this exemption.

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(ii) The lot is identified in the heat treatment records appropriately indicating repeated heat treatment.

§ 178.35(f) *Marking.*

Applies except:

- (1) The marking "DOT-3AA" is replaced by "DOT-E 10603".
- (2) Test pressure must be marked near or following service pressure as "TP" followed by the test pressure.
- (3) Rejection elastic expansion (REE) in cubic centimeters (CC) must be marked near the date of test.

b. TESTING - Fracture toughness (K_{Ic} or J_{Ic}) test: At least two fracture toughness specimens taken from one completed cylinder in each heat of steel must be tested for K_{Ic} values. The valid K_{Ic} data may be obtained via the J-integral test method prescribed in ASTM Standard E813-89. The specimens shall be so tested at room temperature in the T-L orientation as defined in ASTM Standard E399-90. The specimens must be prepared only from material removed from the cylindrical portion of the cylinder. Flattening of the material without heating is allowed for preparing the test specimens. The K_{Ic} value, directly measured or derived from the measured J_{Ic} values must be at least 93 KSI (in)^{3/2}.

The fracture toughness test prescribed is intended for gathering data for the purposes of developing the most appropriate test regimen for the type cylinder authorized in this exemption. The test need not be witnessed by the Inspector, provided the test is performed by a facility acceptable to the Inspector and a certified report of the test results is furnished to the Inspector by the test facility. The test records must be maintained by the manufacturer for a period not less than 5 years and provided to a DOT representative when requested.

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8. SPECIAL PROVISIONS:

a. In accordance with the provisions of Paragraph (b) of § 173.22a, persons may use the packaging authorized by this exemption for the transportation of the hazardous materials specified in paragraph 6, only in conformance with the terms of this exemption.

b. A person who is not a holder of this exemption, but receives a package covered by this exemption, may reoffer it for transportation provided no modifications or changes are made to the package and it is offered for transportation in conformance with this exemption and the HMR.

c. A current copy of this exemption must be maintained at each facility where the package is offered or reoffered for transportation.

d. Each packaging manufactured under the authority of this exemption must be marked with a registration symbol designated by the Office of Hazardous Materials Exemptions and Approvals for a specific manufacturing facility.

e. A current copy of this exemption must be maintained at each facility where the package is manufactured under this exemption. It must be made available to a DOT representative upon request.

f. Cylinders manufactured under the authority of this exemption may not be used for transportation of gases or gas mixtures that would cause hydrogen embrittlement.

g. Filling limits specified in § 173.302(c) are not authorized. Under no circumstances are these cylinders to be filled to a pressure exceeding the marked service pressure at 70°F.

h. Transportation of Division 2.1, (flammable gases) and Division 2.3, (gases which are poisonous by inhalation) are not authorized aboard cargo vessel or aircraft unless specifically authorized in the Hazardous Materials Table (§ 172.101).

i. Reports: A report of the results of tests required by this exemption must be retained by the manufacturer indefinitely as long as the cylinders manufactured under

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this exemption are authorized, and must be made available to an authorized DOT representative upon request.

j. The number of tests prescribed in this exemption is well in excess of those prescribed for DOT specification cylinders. These tests are intended to accumulate a comprehensive array of test results to serve as a basis for developing the most appropriate test regimen for the cylinders manufactured under this exemption. Acceptability of the above cylinders is determined primarily on obtaining satisfactory results from the many standard tests included therein. Evaluation at a future date of the test results from production lots may indicate a need for revision to the currently imposed tests.

k. Each cylinder must be reinspected and hydrostatically retested every five years in accordance with § 173.34, as prescribed for DOT 3AA specification cylinders except that the test pressure is 3/2 times the service pressure. Retest dates must be stamped on the cylinder neck (see § 173.34(e)(7)). Reheat treatment or repair of rejected cylinders is not authorized. When a hydrostatic retest is repeated as provided for in § 173.34(e)(4), only two such retests are permitted. Cylinders, requalified after having been subjected to the actions of fire, must be reported to the OHMEA prior to shipment.

9. MODES OF TRANSPORTATION AUTHORIZED: Motor vehicle, rail freight, cargo vessel and cargo aircraft only (See paragraph 8(h) of this exemption).
10. MODAL REQUIREMENTS: A current copy of this exemption must be carried aboard each cargo vessel or aircraft used to transport packages covered by this exemption. The shipper must furnish a copy of this exemption to the air carrier before or at the time the shipment is tendered.
11. COMPLIANCE: Failure by a person to comply with any of the following may result in suspension or revocation of this exemption and penalties prescribed by the Federal hazardous materials transportation law, 49 U.S.C. 5101 et seq:

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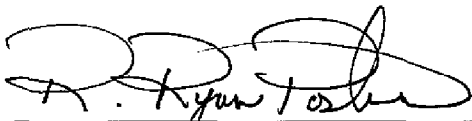
- o All terms and conditions prescribed in this exemption and the Hazardous Materials Regulations, Parts 171-180.
- o Registration required by § 107.601 et seq., when applicable.

Each "Hazmat employee", as defined in § 171.8, who performs a function subject to this exemption must receive training on the requirements and conditions of this exemption in addition to the training required by §§ 172.700 through 172.704.

No person may use or apply this exemption, including display of its number, when the exemption has expired or is otherwise no longer in effect.

12. REPORTING REQUIREMENTS: The carrier is required to report any incident involving loss of packaging contents or packaging failure to the Associate Administrator for Hazardous Materials Safety (AAHMS) as soon as practicable. (Sections 171.15 and 171.16 apply to any activity undertaken under the authority of this exemption.) In addition, the holder(s) of this exemption must also inform the AAHMS, in writing, as soon as practicable of any incidents involving the package and shipments made under this exemption.

Issued at Washington, D.C.



for Robert A. McGuire
Acting Associate Administrator for
Hazardous Materials Safety

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(DATE)

Address all inquiries to: Associate Administrator for
Hazardous Materials Safety, Research and Special Programs
Administration, Department of Transportation, Washington, D.C.
20590. Attention: DHM-31.

The original of this exemption is on file at the above office. Photo reproductions and legible reductions of this exemption are permitted. Any alteration of this exemption is prohibited.

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